

Influence of Nemaguard and Lovell Rootstocks and *Macroposthonia xenoplax* on Bacterial Canker of Peach

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Abstract: 'Fay Elberta' peach trees grown on either 'Lovell' or 'Nemaguard' rootstocks in sandy soil in a lathhouse were highly susceptible to bacterial canker if inoculated with the nematode *Macroposthonia xenoplax* and the bacterium *Pseudomonas syringae*. If either one of these organisms were omitted, serious bacterial canker did not develop. Cankers appeared later and remained small when nematodes were omitted. Very few cankers appeared on trees not inoculated with the bacterium. Peach trees on both rootstocks were good hosts for, and were stunted by, nematodes. Larger numbers of fruit were produced on trees free of bacterial canker or nematodes. Differences in magnitude of bacterial canker symptoms produced experimentally in different years are considered. *Key Words:* *Pseudomonas syringae*, ring nematodes, interactions.

Most of the peach *Prunus persica* (L.) Batsch trees currently sold by California nurseries are on 'Nemaguard' (3) seedling rootstock. This rootstock became popular because of its resistance to root-knot nematodes (*Meloidogyne* spp.) which seriously limited growth of peach trees on 'Lovell' and other rootstocks. According to Lem-bright (5), grower experience suggests that the shift from Lovell to Nemaguard resulted in greater susceptibility to bacterial canker. Zehr et al. (8) found a higher incidence of

peach tree "short life" on Nemaguard than on Lovell rootstocks in two orchards in South Carolina. The immediate causes of tree death in the South Carolina experiment were cold injury, bacterial canker, or both.

The primary purpose of the experiment described here was to test the effects of Lovell and Nemaguard rootstocks on the development of bacterial canker of peaches. A shift back to Lovell rootstock and complete reliance on soil fumigation for control of *Meloidogyne* spp. should not be undertaken without strong evidence that trees on Lovell rootstock have a marked advantage. Because of evidence (6) that *Macroposthonia xenoplax* (Raski) Loof and De Grisse

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(synonym *Criconemoides xenoplax* Raski) increases susceptibility to bacterial canker of peach, this nematode and the canker bacterium, *Pseudomonas syringae* van Hall, were included in this test.

MATERIALS AND METHODS

The experimental location was a lath-house at Davis, California where the 'Fay Elberta' peach trees were grown in 11.4-liter cans of a sandy soil whose analysis by the Boyoucos method (2) was 1% clay, 7% silt, and 92% sand. The cans were sunk in a bed of wood shavings. Variables were rootstock (Lovell or Nemaguard), nematode infestation (20,000 *M. xenoplax* or no nematodes), and bacterial inoculation (inoculated with *P. syringae* or not inoculated). These variables were combined to provide eight treatments (Table 1) which were replicated seven times. In this experiment, the possibility of contamination was considered more important than other effects of plant position. For this reason, like replicates were placed in groups with nematode-infested cans in one-half of the bed, nematode-free cans in the other half, and trees inoculated with bacteria at the two ends so that they were isolated, by means of two polyethylene film barriers, from center trees not inoculated with bacteria. Soil in all cans was kept moist, and

trees were fertilized every 3 weeks with an inorganic N, P, and K fertilizer.

Macroposthonia xenoplax was obtained from earlier experiments (7). The centrifugal flotation method (4) was used to obtain nematode inoculum and to determine final nematode populations. On 25 February 1975, the bare-rooted peach trees were planted in the cans of soil, and water containing 20,000 *M. xenoplax* was poured around the roots of half of them. Trees not receiving nematodes received the same volume of water. The *Pseudomonas syringae*, originally obtained from peach in Merced County, came from our stock culture B-3. A suspension containing 1×10^8 cells/ml was prepared as described previously (6). On 13 November 1975, after trees had grown for 8 months and leaves were abscising, leaf scars on trees receiving bacteria were sprayed with the bacterial suspension. On 7 January 1976, branches of the same trees were inoculated by syringe injection at three places with a similar suspension of the bacteria. Branch injection points were marked with gummed paper tape. Bacterial canker was evaluated on 20 January, 13 February, and 19 April 1976. Measurements of peach tree growth were made after 3 months, 6 months, and 16 months (the end of the experiment). The number of nematodes in each replicate was also determined at harvest. Student's t-test

TABLE 1. Total length of branches killed by bacterial canker, fresh tree weights, numbers of fruit produced/tree, and final numbers of *Macroposthonia xenoplax*/can for Fay Elberta Peach trees with Lovell or Nemaguard rootstock after they were inoculated with *Pseudomonas syringae*, *Macroposthonia xenoplax*, both, or neither.*

	Inoculation of		Bacterial	Fresh tree wt (gm)	No. of fruit per tree	No. of <i>M.</i> <i>xenoplax</i> per can (thousands)
	Soil with <i>M.</i> <i>xenoplax</i>	Branches with <i>P.</i> <i>syringae</i>	Ave. length (cm)* dead branches			
Nemaguard	Yes	Yes	220 a	262 d	0 b	730 b
Lovell	Yes	Yes	164 a	198 d	0 b	196 c
Nemaguard	No	No	207 b	601 ab	2.3 a	0 d
Lovell	Yes	No	117 b	356 c	0 b	1,226 ab
Nemaguard	Yes	No	147 b	401 c	0.8 a	1,494 a
Lovell	No	Yes	1 b	491 b	0.6 ab	2.8* d
Nemaguard	No	Yes	1 b	652 a	3.8 a	1.8* d
Lovell	No	No	0 b	657 ab	1.8 a	0 d

*In each column averages followed by the same letter do not differ at the 5% level of significance.

*Because we did not inoculate these trees with bacteria, cankers must have resulted from contamination or natural infection.

*Nematode infestation indicated by this average was contamination.

was used to judge the probability that differences between treatments were the result of chance.

RESULTS

Bacterial canker: On 20 January, 10 weeks after the spray inoculation with *P. syringae* and 2 weeks after the branch injection, cankers had appeared only on trees inoculated with both *P. syringae* and *M. xenoplax*. There was no difference in number or size of cankers between trees on Lovell and trees on Nemaguard rootstock. Because inoculation sites had been marked with tape, cankers arising from spray could be distinguished from those arising from injection. There was no significant difference between the number or size of cankers arising from these two methods of inoculation. By 13 February, some cankers had appeared on all trees inoculated with bacteria, whether inoculated with nematodes or not. On 11 March, 17 weeks after spray inoculation and 9 weeks after branch injection, trees were in full bloom. All trees except those inoculated with both organisms were covered with blooms. Cankers in this treatment, whether on Lovell or Nemaguard, had enlarged greatly by this time and killed much of the top growth. There were very few blooms. Cankers around syringe injection points had not enlarged greatly, and we conclude that the leaf scars were the probable entry courts for the effective bacterial infections. By 19 April, when trees had leafed out, bacterial canker remained about the same as at full bloom. This disease had become serious only when trees were infected with both *M. xenoplax* and *Pseudomonas syringae* (Fig. 1). Disease was not affected significantly by rootstock (Table 1).

Peach growth and fruit production: After 3 months, trees on Nemaguard rootstock (average trunk diameter 11.4 mm) were larger ($P = <0.01$) than those on Lovell (9.6 mm), and nematode-inoculated trees (average trunk diameter 11.1 mm) were larger ($P = <0.01$) than nematode-free trees (9.9 mm). Trees were not measured immediately after planting, and the differences may have existed at this time. After 6 months, trees on Nemaguard continued to be larger, but nematode-inoculated and nematode-free trees did not

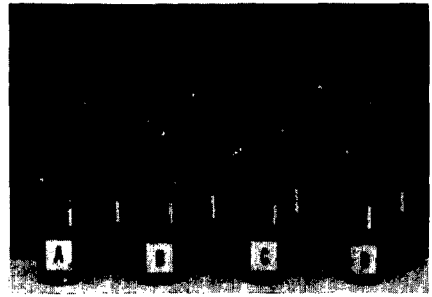


FIG. 1. Fay Elberta peach trees on Lovell rootstocks (front row) or Nemaguard rootstocks (rear row) 14 months after they received treatments. A) Noninoculated. B) Inoculated with *Macroposthonia xenoplax*. C) Inoculated with *Pseudomonas syringae*. D) Inoculated with both nematodes and *P. syringae*.

differ. When the experiment was terminated after 16 months, the fresh weights of trees inoculated with nematodes were less (Table 1) than the fresh weights of noninoculated ones; trees on Lovell did not differ in fresh weight from those on Nemaguard.

Tree growth was suppressed most when trees were inoculated with *P. syringae* and *M. xenoplax* and serious bacterial canker developed (Table 1). The nematodes alone retarded tree growth on both rootstocks. On the basis of weight losses, trees on Lovell were at least as susceptible to this nematode as were those on Nemaguard. Fewer feeder roots were present on nematode-infected plants, as was observed in an earlier experiment (6). No swollen lenticels were observed. Bacterial canker developed, and the experiment was terminated before hot weather aggravated secondary waterlogging effects (6). *Pseudomonas syringae* alone had no effect on fresh tree weight because serious bacterial canker did not develop without nematodes. The stunting (caused by bacterial canker or nematodes) of peach trees on Lovell rootstock did not differ from the reductions on Nemaguard rootstock. Inoculation with *M. xenoplax* suppressed fruit production (Table 1).

Final population levels of nematodes: When the experiment was harvested, 10 of the 28 trees intended to be nematode-free were found to be badly contaminated with *M. xenoplax*. No contaminated replicates had developed serious bacterial canker, probably because the contamination occurred too late to predispose them to disease this season. Data from these trees

were excluded, however, and degrees of freedom for the treatments affected were reduced correspondingly. Data from four, lightly contaminated trees were included in the analysis (Table 1).

Both rootstocks were good hosts for *M. xenoplax*, as has been reported previously (1). Inoculation with both *P. syringae* and *M. xenoplax* resulted in lower final numbers of *M. xenoplax* than inoculation with *M. xenoplax* alone. This response was probably a result of the detrimental effect of bacterial canker on the tree and its root system.

DISCUSSION

Although the number of replicates in this experiment was initially seven, it was finally reduced to four or five, in the case of nematode-free treatments, because of nematode contamination. This number of replicates only permits detection of large differences. Nevertheless, it is obvious that the peach trees on either Lovell or Nemaguard were highly susceptible to bacterial canker and nematode disease. Poor experience with peach trees on Nemaguard root in the southeastern United States may be a consequence of greater susceptibility to winter injury with Nemaguard than with Lovell. Brooks and Olmo (3) alluded to this trait in Nemaguard when it was introduced. Winter injury to peaches is not an important problem in California. We do not think that present evidence warrants a general reversion to use of the root-knot susceptible Lovell rootstock in California. Further comparison of the two rootstocks in the field would be useful.

An earlier (1971-72) experiment described in a previous paper (6) demonstrated that *P. syringae* caused larger cankers on trees parasitized by *M. xenoplax* than on nematode-free trees. In that experiment, however, we produced very little serious bacterial canker, such as occurs naturally in the San Joaquin valley. In the 1975-76 experiment described in this paper, we produced serious bacterial canker in all trees inoculated with *M. xenoplax* and *P. syringae*. What is the reason for the differing results? The experiments had much in common—the same lathhouse site, sand

medium, and inclusion of Lovell rootstock. Different top varieties were used, but no top variety is known to possess resistance to bacterial canker. An examination of climatological data, compiled by the United States Department of Commerce, for California revealed that air temperatures during the critical period of 1 December to 28 February, after leaf scar inoculation had occurred, were quite similar for the two experiments. Rainfall was not similar. It totaled 15 cm during this period of the first experiment and only 3 cm in the second one. During cool months, experimental trees in the lathhouse are seldom watered. Thus, soil moisture would be affected by rainfall. The San Joaquin valley, where bacterial canker of peach is serious, usually receives less rainfall than Davis, California, where bacterial canker of peach is rare. Some factor in addition to the bacteria and nematodes, whether soil moisture or another, appears essential to the development of bacterial canker disease in California. At present, the easiest factor to control among those known to be essential for bacterial canker on peach is the nematode population.

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